

REMARKS

The claims have been revised to more clearly define applicants' invention. As revised, the claims clearly show that adduct ions which are formed by a combination of sample ions and solvent molecules are dissociated or converted to sample ions without fragmentation of sample ions prior to entering the mass spectrometer.

As is known, a goal to be achieved in single or multiple interface vacuum chambers which precede a low-pressure mass analyzer is to transport as many of the sample ions as possible from the atmospheric pressure ionization source to the mass analyzer. However, many solvent adduct ions which are formed travel through the interface vacuum chambers into the analyzer. The process of solvent adduction in a mass spectrometer is generally considered to be the non-covalent combination of sample ions of interest and neutral solvent molecules. The formation of adduct ions significantly reduces the abundance of sample analyte ions. Furthermore, the adduct ions which enter into the mass analyzer complicate the mass spectrum and make the identification of mass peaks more difficult. In accordance with the teaching of the present invention, the sample and adduct ion translation kinetic energy is chosen such that, at the vacuum pressure of the interface chamber, adduct ions are converted into sample ions by collision induced association without fragmentation of sample ions. The sample ion current entering the analyzer is thereby increased, increasing the sensitivity of the mass spectrometer system.

Applicants have carefully studied U.S. Patent 5,652,427 and admit that this patent shows a mass analyzer disposed in a high vacuum chamber for analyzing ions formed at or near atmospheric pressure and directed to the analyzer through intermediate vacuum chambers, and that the sample ions travel through the chambers without fragmentation.

Applicants' invention, however, is directed to the dissociation of adduct ions prior to entry into the mass analyzer, whereby they form sample ions which increase the sample ion current entering the mass analyzer. There is no teaching in this patent, nor would it have been obvious to one with ordinary skill in art at the time of the invention, to modify the Whitehouse patent in the manner required by the present claims. There is no teaching of disassociating adduct ions to form sample ions which together with those sample ions which are not adducted with solvent molecules increases the ion current.

Claim 1 clearly specifies this feature by calling for means associated with first and second multiple ion guides converting adduct ions into sample ions without fragmentation of the


remaining sample ions whereby to increase the sample ion current. Each of the remainder of the claims includes a similar limitation.

In view of the foregoing amendment favorable action is respectfully requested.

Attached hereto is a marked-up version of the changes made to the specification and claims by the current amendment. The attached page is captioned "Version with markings to show changes made."

The Commissioner is hereby authorized to charge any other fees determined to be due to Deposit Account 06-1300 (Order No. A-67824-1/AJT).

Respectfully submitted,



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In the Claims:

Amend the claims as follows. All pending claims are listed below, whether amended or not, for the Examiner's convenience.

1. (amended) A mass spectrometer system including a mass analyzer disposed in a high vacuum chamber for analyzing sample ions formed at atmospheric pressure and directed to the analyzer through intermediate vacuum chambers in which sample ions and solvent molecules form adduct ions with a reduction of sample ion current including:

first and second evacuated chambers directly preceding the mass analyzer chamber with the first chamber being at a higher pressure than the second chamber,

a first multipole ion guide in the first chamber for guiding ions into said second chamber,

a second multipole ion guide in the second chamber for guiding ions from the first chamber into the high vacuum chamber for mass analysis, and

means associated with one or both of said first and second multipole ion guides for increasing the translational kinetic energy of the adduct ions so that at the vacuum pressure of the second interface chamber adduct ions traveling into the chamber are converted into [protonated molecular cations or molecular anions] sample ions without fragmentation of [these] sample ions whereby to increase the sample ion current and therefore the sensitivity of the mass spectrometer system.

2. (unchanged) A mass analyzer as in claim 1 including ion lenses preceding each said multipole ion guide and a DC voltage is applied between a selected lens and its associated ion guide to increase the translational kinetic energy of the adduct ions entering the second interface chamber.

3. (amended) A method of mass analyzing sample ions produced at atmospheric pressure[, in which adduct ions are formed,] and introduced into a mass analyzer disposed in a vacuum chamber, and in which some sample ions and solvent molecules combine to form adduct ions with a reduction of sample ions comprising the step of dissociating the adduct ions prior to entry into the mass analyzer to form sample ions to increase the [analyte] sample ion current entering into the mass analyzer.

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4. (amended) The method of operating a mass spectrometer system including a mass analyzer which analyzes sample ions formed at atmospheric pressure, and in which some sample ions and solvent molecules combine to form adduct ions with a reduction of sample ions, said system including first and second multipole ion guides disposed in serial first and second evacuated chambers separated by an ion lens for guiding analyte ions into said mass analyzer and an ion lens defining the first evacuated chamber which comprises

applying a DC offset voltage between a selected one or both ion lenses and the succeeding multipole ion guide having an amplitude so as to provide translational kinetic energy to said adduct ions to dissociate the adduct ions without dissociating sample ions at the pressure of the second chamber to increase the sample ion current and the sensitivity of the mass spectrometer system.

5. (unchanged) A mass spectrometer system as in claim 4 in which the pressure in the first chamber is below 500 mTorr, and in the second chamber is below 1 mTorr, and the offset voltage applied between the interchamber lens and the second multipole ion guide is between ± 10 volts and ± 30 volts.

6. (unchanged) A mass spectrometer system as in claim 5 in which the pressure in the first chamber is less than 250 mTorr, and in the second chamber is less than 0.7 mTorr.

7. (unchanged) A mass spectrometer system as in claim 5 in which the pressure in the first chamber is less than 175 mTorr, and in the second chamber is less than 0.5 mTorr.

8. (unchanged) A mass spectrometer as in claim 6 or 7 in which the offset voltage is ± 10 volts.

9. (amended) The method of analyzing ions[and adduct ions produced at or near atmospheric pressure] in a mass analyzer which includes a first chamber maintained at a first pressure and a second chamber maintained at a lower pressure comprising the steps of:

forming sample ions at atmospheric pressure with some of the sample ions combining with solvent ions to form adduct ions,

guiding said sample ions and adduct ions through at least a first chamber maintained at a first pressure and a second chamber maintained at a lower pressure,

adding translational kinetic energy to said adduct ions as they travel through said chambers such that in the second chamber the adduct ions are dissociated without fragmenting the sample ions prior to entering the mass analyzer.

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